

REMARKS

This responds to the Office action mailed March 24, 2004. The fourth-month date (July 24) is a Saturday, so this is submitted within four months by being submitted on Monday, July 26.

\* Enclosed is a check for \$110.00 for a one-month extension.

With regard to applicants' election of species, applicants' Amendment A stated the following:

In response to the species election requirement, applicants respectfully traverse the requirement, and hereby elect the claims of Group (e) for examination. Applicants understand that Group (e) as defined by the Examiner includes claims 10, 17, 31, and 50: "... wherein the defect reducing agent is a reaction product of benzyl chloride and hydroxyethyl polyethylenimine."

This election was ambiguous, due to a clerical error by the undersigned attorney, because it elected "claims 10, 17, 31, and 50: ... wherein the defect reducing agent is a reaction product of benzyl chloride and hydroxyethyl polyethylenimine," but stated this was Group (e). The correct group was Group (c). The undersigned understands that in order to correct this mistake, it is necessary for the undersigned to overcome the cited art with respect to Group (e), which will allow the Examiner to move on to consideration of the next elected species. Applicants have therefore canceled the claims of Group (e) -- claims 12, 19, 33, and 52 -- even though they were stated in the March 24, 2004 Office action to be allowable. The

claims of Groups (a), (b), (d), and (f), i.e., claims 8-9, 11-13, 15-16, 18-20, 29-30, 32-34, 48-49, and 51-53, have also been canceled. Applicants therefore request the Examiner to move to the next elected species (Group (c); claims 10, 17, and 31), and the claims generic thereto.

Reconsideration is requested of the objection to the specification. The embodiment of the deposition process described in the specification is cathodic deposition. In cathodic deposition, the substrate itself functions as a cathode, and a separate element functions as a counterelectrode, i.e., as an anode. Pages 9-11 of the specification describe that substrate 12 (Figs. 9 and 10) functions as a cathode. Accordingly, in the context of the figures, the terms "substrate," "cathode," and "cathode substrate" are all accurate and are interchangeable. Element 12a simply refers to the surface of this cathode substrate.

Element 11 is also shown in these figures and refers to the electroplating tank, also known as the holding tank. These terms designate the exact same element. Page 10 of the specification is amended above to clarify this.

Reconsideration is requested of the objections under section 112. The claims 2, 44, and 46, and claims 28 and 43, have been amended to address the antecedent basis issues and the essential element issue.

Reconsideration is respectfully requested of the rejection of claims 28 and 35 under section 102 over Dubin et al. With respect to claim 35, it has been canceled, rendering the rejection moot. With respect to claim 28, it has been amended

to include a further characteristic or quality of the defect-reducing agent. In particular, this claim is limited to concentrates which have a defect-reducing agent which reduces a rate of recrystallization and grain growth in deposited copper, thereby reducing the formation of internal voids.

It is asserted on page 5 of the Office action that this claim limitation does not compositionally distinguish the concentrate from the prior art. Conventional leveling agents as referred to at column 6, line 15 of the cited Dubin et al. reference are known to have a leveling effect on the deposit, which is a phenomenon related to surface morphology and superfilling of deep, narrow features. However, Dubin et al. do not teach the selection of agents (leveling agents or otherwise) which "reduce the formation of internal voids" by "reducing the rate of recrystallization and grain growth."

Applicants' specification beginning at page 4, line 1 addresses the distinctions between the types of defects addressed by conventional leveling agents, and the types of defects addressed by defect-reducing agents having the features of the agents in claim 28:

Certain defects in deposited copper can occur due to locally uneven growth of copper crystals. Other defects formed after deposition, applicants believe, can be attributed to recrystallization and grain growth in the deposit. In particular, there are changes in volume resulting from grain growth, which changes in volume produce stress-induced defects. These volume changes also cause a degree of detachment of the deposit from the via and trench walls, which constitute defects. And recrystallization causes spontaneous internal voids as grain boundaries are eliminated.

Not all agents which are capable of this leveling suppression reduce multiple types of defects as described herein. Certain classes of compounds have been identified herein to reduce multiple types of defects.

It has also been observed that these leveling compounds added to the plating bath have an effect of decreasing voiding by inhibiting, or at least slowing the rate of, recrystallization in the deposit.

Accordingly, applicants respectfully submit that their concentrate of claim 28 does, in fact, compositionally distinguish from Dubin et al.'s concentrate because Dubin et al.'s concentrate does not have any agent stated to "reduce the rate of recrystallization and grain growth." These limitations of claim 28 describe a feature of the claimed agents, and distinguish the overall concentration from the cited art. Applicants therefore respectfully request allowance of claim 28.

Reconsideration is requested of the rejection of claims 43-47 under section 102 over Dubin et al. Claim 43 has been amended to require that the defect reducing agent is a reaction product of benzyl chloride and hydroxyethyl polyethylenimine. This feature is not disclosed or suggested by Dubin et al. Claims 44-47 have been canceled. Applicants therefore respectfully request allowance of claim 43.

Reconsideration is requested of the rejection of claims 1-7 under section 103 as obvious over Dubin et al. Claim 1 has been amended to require that the defect reducing agent is a reaction product of benzyl chloride and hydroxyethyl polyethylenimine. This aspect is neither disclosed nor suggested by Dubin et al. Applicants therefore request allowance of claims 1-7.

Reconsideration is requested of the rejection of claim 14 under section 103 as obvious over Dubin et al. Claim 14 expressly requires immersing the substrate into an electroplating bath including a defect reducing agent which reduces a rate of recrystallization and grain growth in the copper deposit, thereby reducing the formation of internal voids within the copper deposit. This is an express requirement of claim 14 which cannot be ignored in assessing patentability.

The basis for the rejection as stated on page 12 of the Office action is as follows:

Dubin appears to disclose a method at least in a similar manner as instantly claimed. Therefore, it would have been within the skill of the art to expect the deposit subsequently undergoes recrystallization and grain growth at a reduced rate, unless proven otherwise.

Claim 14, however, does not simply require that the deposit undergo recrystallization and grain growth at a reduced rate. Rather, it requires more positively that a step of the operation involve immersion in a bath which includes an "agent which reduces a rate of recrystallization and grain growth." The phenomena Dubin et al discuss all relate to the actual filling process, and avoiding the formation of seams during the filling process because "Cu commenced plating at the bottom of the opening and progressed substantially sequentially to the top of the opening ...." (Col. 6, ln. 47). This is a reference to "superfilling," which is the concept of filling a high aspect ratio<sup>1</sup> via without "pinching off" which manifests itself as

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<sup>1</sup>I.e., a via which is much deeper than it is wide.

seams. Dubin et al. say nothing about recrystallization and grain growth after filling, and avoiding the post-fill formation or exacerbation of voids by slowing down the rates of recrystallization and grain growth. Nowhere does the Dubin et al. reference suggest anything about the rate of recrystallization and grain growth, and nowhere does it suggest incorporating into the bath any agent which affects the rate of recrystallization and grain growth. Accordingly, there is no basis upon which one skilled in the art might conclude that Dubin et al.'s "deposit subsequently undergoes recrystallization and grain growth at a reduced rate." Applicants therefore request reconsideration of the basis for the rejection of claim 14, and withdrawal of the rejection.

Applicants also request reconsideration of the basis for the rejection of claim 14, because the Office has improperly attempted to shift the burden of proving non-obviousness to the applicants: "unless proven otherwise." The burden is on the PTO to establish *prima facie* obviousness:

The Examiner bears the initial burden of factually supporting any *prima facie* conclusion of obviousness. MPEP 2142.

The burden is not on the applicants to "prove otherwise":

If the Examiner does not produce a *prima facie* case, the applicant is under no obligation to submit evidence of nonobviousness. MPEP 2142.

The Office's rejection focuses only on the differences between the processes (applicants require an agent which reduces the rate of recrystallization and grain growth; Dubin et al. do not), and does not establish why it would have been obvious to

ignore these differences. In fact, from the information of record, it would not have been obvious. It is error to by-pass this analysis by stating "unless proven otherwise." By shifting the burden to the applicants to prove that Dubin et al.'s process al.'s "deposit subsequently undergoes recrystallization and grain growth at a reduced rate," the Office has ignored the initial burden to make a *prima facie* case of obviousness.


Applicants therefore respectfully request allowance of claim 14.

**CONCLUSION**

In view of the above, applicants request issuance of a Notice of Allowance for pending claims 1-7, 14, 17, 28, 31, 43, and 54-59.

Applicants understand that the claims in Group I to additional species other than Group (c) will be considered upon allowance of a generic claim. Claims 1-20, 28-35, and 43-53 are in Group I, of which claims 1-7, 14, 28, 35, and 43-47 are generic, as stated on page 4 of the Office action.

Respectfully submitted,



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\*Enclosure

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